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LEAN MANUFACTURING AND IUP MATRIX ANALYSIS TO IMPROVE THE PRODUCTION TIME OF FOOD CONTAINER AT UD GAJAH DELTA

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ABSTRAK

UD. Gajah Delta merupakan UMKM produsen peralatan dapur yang berlokasi di area pemukiman, dimana lokasi gudang di seberang jalan lokasi proses produksi yang memperlambat aliran bahan baku dan produk setengah jadi. Rantang merupakan produk dengan order tertinggi. Beberapa hambatan yang dihadapi , yaitu lokasi bahan baku dan proses produksi yang berbeda, operator sakit di pergelangan tangan karena mengoperasikan mesin dengan memutar handle, lintasan kasar untuk produk menyebabkan aliran produk terhambat, operator tidak masuk, operator sering mengobrol, tahapan proses produksi banyak tetapi pengaturan tata letak yang tidak baik, menunggu bahan, kurangnya kebersihan area, peralatan proses produksi kurang. Mayoritas karyawan kurang mampu berkoordinasi, mengidentifikasi masalah dan menyelesaikan masalah produksi sehingga waktu produksi menjadi lebih lama.
Untuk memperbaiki problem di atas maka digunakan metode *Lean Manufacturing* untuk mengidentifikasi *Value adding Activities, Non Value Adding Activities.* Dengan melakukan kuisioner dan *brainstorming* maka diperoleh tiga pemborosan terbesar yaitu *transportation, employee behavior,* dan *unnecessary motion.* Untuk menemukan akar permasalahannya digunakan *five whys* kemudian diusulkan saran perbaikan dengan pembobotan berdasarkan *Importance, Urgency, Priority* (IUP).
Dari perbaikan tersebut waktu produksi rantang mengalami penurunan 46,32% , *Value Adding Activity* mengalami kenaikan 31,64% dengan mengurangi *Non Value Adding Activity* 58.83*%.* Hal ini berdampak positip pada pengembangan bisnis.

Kata kunci: *Lean Manufacturing, Motion, Transportation, Behavior, IUP*

ABSTRACT

UD. Gajah Delta is an MSME kitchen equipment manufacturer located in a residential area, where the warehouse is located across the road from the production process which slows down the flow of raw materials and semi-finished products. Food container is the product with the highest orders. Some of the obstacles faced, namely the location of raw materials and the production process are different, the operator has pain in the wrist from operating the machine by turning the handle, rough paths for the product caused product flow to be hampered, the operator does not enter, the operator often chats, there are many stages in the production process but the arrangements poor layout, waiting for materials, lack of area cleanliness, lack of production process equipment. The majority of employees are less able to coordinate, identify problems and resolve production problems, resulting in longer production times.
To fix the problem above, the Lean Manufacturing method is used to identify Value Adding Activities (VAA), Non Value Adding Activities. By conducting questionnaires and brainstorming, the three biggest wastes were obtained, namely transportation, employee behavior, and unnecessary motion. To find the root of the problem, five whys are used, then suggestions for improvement are proposed with weighting based on Importance, Urgency, and Priority (IUP).
From these improvements, food container production time decreased by 46,32%, Value Adding Activity increased by 31.64% by reducing Non Value Adding Activity by 58.83%. This has a positive impact on business development.

Key word: *Lean Manufacturing, Motion, Transportation, Behavior, IUP*

INTRODUCTION

UD. Gajah Delta wants to expand the MSME that its parents started, which currently employs around 50 people. This MSME is located in a residential area of Kebakalan Village and has four house locations that are used as warehouses and production areas located across the road as shown in Figure 1. This leads to a problem when filling and removing raw materials or the finished products.

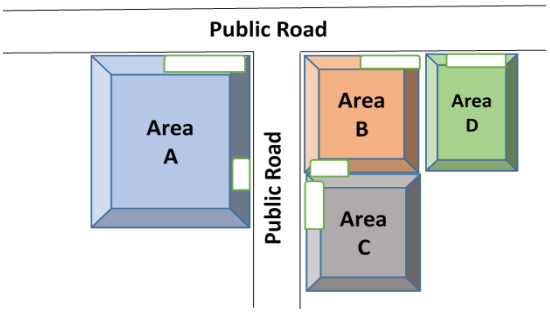


Figure 1. Warehouse and Production Area

UD. Gajah Delta produces a variety of kitchenware products with various sizes from small to large, such as food containers, stacking food containers, boilers, and pans, with manual production processes and poor machine layout. Those things cause long production process times.

The majority of UD. Gajah Delta customers come from East Java, especially Sidoarjo. In recent years, customers, also come from outside East Java, especially Central Java, Bali, Lombok, Kalimantan, and Sulawesi. From the sales data for the period of March - June 2024, a periodic sales percentage graph is obtained as shown in Figure 2.

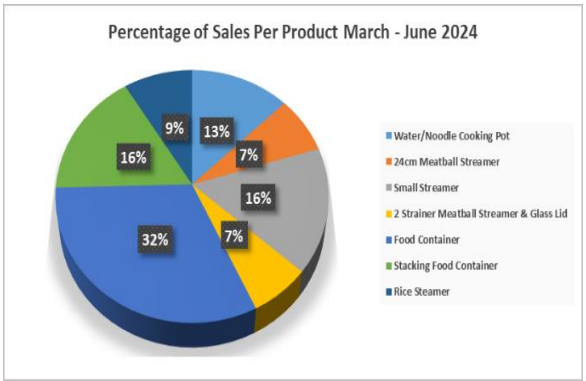


Figure 2. Percentage of Sales Per Product March – June 2024

From figure 2 shown that the highest sales are food containers. This food container product is also called a single food container with the names of the product parts being the food container body, handle and food container lid as in figure 3.

Figure 3. Single Food Container Part's Name

The food container with the highest sales experienced serious problems in the production process due to the process of moving raw materials, while the different work areas between the placement of raw materials and the production area across the road resulted in a high waste of time. This is a serious problem for the food container production process because the production process time is not in accordance with the expectations of the UD. Gajah Delta's leader. One of the problems in making food containers is the collection of raw materials at the location of house A, while the production process at houses B and C is located across the road, so the process of transporting raw materials becomes long and requires a transportation tool and requires one production employee to take the raw materials. Because it takes a long time and additional work for the production operator, so that the performance of the production process time is not as expected by the leader, it happens because of the lack of ability to identify problems that occur in the production process area. Other problems encountered are employees often chatting (gossiping) while working, especially when picking up materials in other buildings or during on the way to the place where the materials are picked up, operators insulting other operators, such as when the operator makes a mistake, the machine or the product produced is bad. Then, operators often leave the place to take semi-finished products that stop in the middle of the track between the machine and the semi-finished product storage tub for the next process, operators move garbage that blocks the operator when carrying materials or semi-finished products, and also often operators take tools that are far away to carry out machine repairs.

The purpose of this study is to identify waste and non-value-added activities that occur in the food container production process using the lean manufacturing method based on nine waste criteria. After that, prioritize improvement proposals by weighting based on IUP (Importance, Urgency, and Priority) to improve the food container production process.

This research has limitations, that is focusing on one Food Container product, because the product has the highest sales, the process stages are complex due to the number of machines used more than 10 units with different locations in areas A, B and C.

RESEARCH METHOD

The Lean Manufacturing method is used to solve the problems that occur at UD. Gajah Delta. The data collected were obtained from primary data conducted questionnaires and secondary data by conducting interviews and observations at UD. Gajah Delta. The flowchart of this research can be seen in Figure 4.

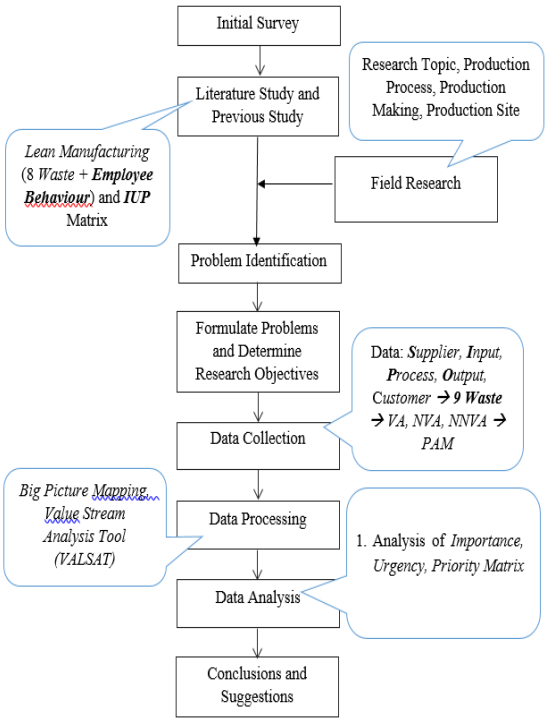


Figure 4. Research Flow Diagram

Lean Manufactuirng

Lean manufacturing is a method to identify, minimize, and eliminate waste by making continuous improvements, so as to optimize the performance of the manufacturing process. (Pradana et al., 2018).

Another definition of lean manufacturing put forward by Sanders et al., 2016, is activities that can add value to customers so as to reduce production time, increase productivity, and reduce waste.

There are five Lean principles according to Gaspersz, 2018, i.e. :

1. Set value based on customer perception.
2. Identify waste along the Value Stream Mapping (VSM).
3. Draw the value stream to eliminate waste along the Value Stream Process Mapping.
4. Establish a customer pull system for the flow of information, materials and products so that it becomes more efficient.
5. Perfection by conducting continuous activities.

There are nine categories of waste: overproduction, excess inventory, defects, extra processing, waiting, motion, transportation, underutilized people, employee behavior (Charron et al., 2015).

Employee behavior is a new category of waste but is often done by employees, such as counter-productive behavior of an employee in an organization that will directly or indirectly affect the performance of the organization, not taking the initiative to make improvements, absenteeism, avoiding tasks, harassing other employees and so on (Patrick & Matthieu, 2019).

Wasteful Employee Behavior is caused by human interactions that harm individuals and groups in the workplace. Examples are gossip, disharmonious relationships between employees, individual barriers, egos, unfavorable employee comments, and so on (Taqwanur, 2021).

The result of lean manufacturing analysis is the acquisition of Value Added Activity (VAA), Non Value Added Activity (NVAA) and Necessary but Non Value Added Activity (NNVAA) from the waste that occurs (Gaspersz, 2018).

Meanwhile, according to Faulkner & Badurdeen, 2014, Value Stream Analysis Tools will describe the visualization of Value Stream Mapping by explaining the flow of information, product flow in current conditions and future conditions, so that this will provide opportunities for improvement to reduce production process time so that it has an impact on increasing production capacity.

Sumasto et al., (2024) stated that the successful application of lean manufacturing in the tofu industry MSMEs by reducing or eliminating waste motion and waste waiting so that efficiency and productivity can be increased.

Harjanto & Karningsih, (2021) which states that the application of lean manufacturing and JIT is also useful for MSMEs, even MSMEs in many countries have successfully used lean methods. The use of lean manufacturing in MSMEs aims to improve the business, such as improving efficiency and flexibility, harmonious communication with customers, resulting in faster response and feedback at a lower cost.

Data Collection

Data collection activities include material flow, production time data, defective products, production process data, waste questionnaires to obtain Value Added Activity (VAA), Non-Value Added Activity (NVAA) and Non-Necessary Value Added Activity (NNVAA).

By doing Process Activity Mapping (PAM) will know all the activities of the production process by classifying the category of waste that occurs so as to eliminate Non-Value Added Activity (NVAA). This has an impact on the process becoming more efficient by opening up

opportunities for improvement by minimizing waste (Misbah et al., 2015).
The identification process of VAA, NVAA, and NNVAA is carried out based on the activities of operation, transportation, inspection, storage, and delay.

Data Processing
The next step is data processing from the questionnaire results using big picture mapping and VALSAT.

Analysis
The next step is analyse the big picture mapping, VALSAT, and suggest improvements to minimize waste. After that, conduct a weighting analysis with consideration of the Importance, Urgency, Priority (IUP) Matrix with the aim of obtaining improvement priorities. That matrix considers for the ease of implementation with limited time and resources (Syah et al., 2019).

Nine kinds of waste are as follows:
1. Overproduction, such as a lot of production stock in the production area and warehouse.
2. Defects, e.g., defective products, product imperfections, product quality problems during production.
3. Excess inventory is the storage of stock inventory that exceeds the volume capacity of the warehouse or production area.
4. Extra processing or excessive processing because there are products that do not meet specifications so that additional processes are needed to correct due to incorrect use of equipment or process errors due to a lack of procedures.
5. Transportation is the movement or transfer of excess material, which results in longer time, greater effort, and high costs; for example, moving goods many times, waiting for tools, and long distances to pick up materials or goods.
6. Waiting is the process of waiting for materials or products from the previous process. For example, waiting for the arrival of equipment can delay the process.
7. Unnecessary Motion is the unnecessary movement of materials, products, and labor during the production process so that productivity decreases. For example, the arrangement of work areas that are less efficient, not ergonomic, equipment or components outside the operator's reach.
8. Underutilized People is the waste of underutilized employees when leaders cannot recognize and utilize the mental, creative, innovative, and physical skills or abilities of these employees. For example, business thinking and culture inhibit the use of employees' creative skills, giving innovative tasks that can result in process improvements.
9. Employee behavior is the counterproductive behavior of an employee in an organization that will directly or indirectly affect the performance of the organization, for example, not taking the initiative in making improvements, absenteeism, avoiding tasks, or harassment.

RESULTS AND DISCUSSION

Data processing activities begin with the flow of the food container making process at UD. Gajah Delta, which is shown in Figure 5.
The process of flowing raw materials, semi-finished products, making this food container through the highway from building A, building B, and building C. This is an obstacle so that the production time becomes long.

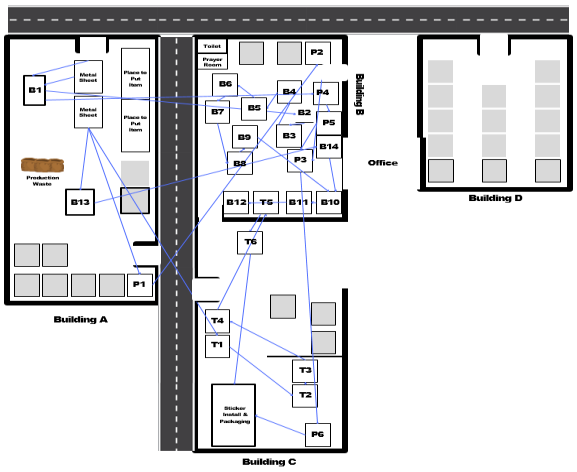


Figure 5. Process Flow of Making Food Container Product

Based on Figure 3 above, which describes the single food container that consist of the food container body, food container lid, and food container handle. From the process of making the food container parts, the longest time in making food container is the food container body which requires 75.29% of the total food container production time, this can be seen in Figure 6.

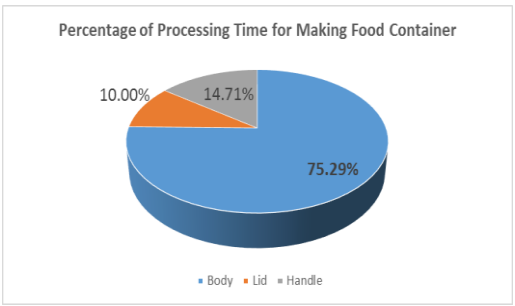


Figure 6. Percentage of Time for Making Food Container

So the focus of improvement is to reduce the processing time of making the food container body.

From table 1, there are thirteen steps to produce the food container body. The steps in making the food container body by taking into account the operating time, transportation time, inspection time, storage time, and delay time that occur in the production process flow.

From table 1, it can be seen that the highest delay time is 1,643 seconds. Delay time is something that does not add value, so it is necessary to make an improvement plan to reduce this time.

Table 1. Operation Time, Transportation, Inspection, Storage and Delay

Process	Activity	Distance	Operator	Process Time (sec)					Time (sec)		
				O	T	I	S	D	VAA	NVAA	NNVAA
Food Container Body Size Chart	Take steel sheet from storage rack to cutting machine	2 m	2		20		23	51	43	51	
	Draw the size of the food container body on the steel sheet		1	56				49	56	49	
Cutting Machine	Cut the steel to the size of the food container body		1	72	63			176	135	176	
Point Machine	Transfer the cut steel from warehouse A to warehouse B	15 m	1	50	132			235	132	235	50
	Put points on the steel		1	41					11	30	
Tip Vise Machine	Make a vise at both ends of the part	0.5 m	1	51				76	51	76	
Rolling Machine	Bending Process (Rolling)	0.5 m	1	67				53	67	53	
Joining Machine	Send to the joining machine	1 m	1		30			23	30	23	
	Joining process		1	80				45	80	45	
Profile Side Machine	Put into the storage area	2 m	1		30			20	30	20	
	Bottom profile side process		1	96				87	96	87	
	Check the edge quality		1			30		22	30	22	
Process Food Container Machine	Products are sent to the pressing process area	2 m	1		30			24	30		24
	Pressing process		1	91		65		56	156	56	
Groove Making Machine	Make a groove	2 m	1	82		50		114	132	114	
Bottom Profile Side Machine	Sending products to the profile side processing site	1 m	1		30			26	30		26
	Bottom side profile process		1	111				36	111	36	
	Perform a check with the bottom part		1			30		14	30	14	
	Sending food container bottom material	4 m	1		35			81	35	51	30
Food Container Bottom Press Machine	Put the bottom part food container	2 m	1	81				51	81	51	
Food Container Bottom Side Machine	Bottom side manufacturing process	1 m	1	105				81	105	81	
	Check the bottom side		1			61		151	61	151	
Bottom Pressing Machine	Steel material with a diameter of 16 cm is sent to the press machine	4 m	1		57			53	57		53
	Pressing process (forming)		2	63					63		
Body with Bottom Joining Machine	The results of the food container bottom are sent to warehouse B	2 m	1		30		13	51	43	51	
	The process of merging the bottom with the body of food container		1	62				68	62	68	
	TOTAL		28	1,108	457	236	36	1,643	1,757	1,540	183

After that, time is calculated based on Value Added Activity time, Non Value Added Activity time, and Necessary Non Value Added Activity time.

Table 2. Time of *VAA, NVAA and NNVAA – Current*

Activity Process	Time Description (sec)		
	VAA	NVAA	NNVAA
Steel Cutting Machine	234	276	0
Steel Point Machine	143	265	50
Steel Tip Vise Machine	51	76	0
Rolling Machine	67	53	0
Joining Machine	110	68	0
Side Profile Bottom Machine	156	129	0
Food Container Body Press Machine	186	56	24
Food Container Groove Making Machine	132	114	0
Bottom Side Profile Machine	206	101	56
Food Container Bottom Side Machine	81	51	0
Bottom Food Container Machine	166	232	0
Bottom Pressing Machine	120	0	53
Body with Bottom Joining Machine	105	119	0
Total	1757	1540	183

From table 2, the result of Value Added Activity time is 1,757 seconds and Non Value Added Activity time is 1,540 seconds. Knowing the amount of time will make it easier to analyze the data in the next step.

Table 3. VALSAT Analysis

Tools	Weighting	Ranking
Process Activity Mapping	495	1
Demand Amplification Mapping	383	2
Quality Filter Mapping	302	3
Supply Chain Response Matrix	282	4
Physical Structure	278	5
Decision Point Analysis	228	6

After analyzing the time of Value Added Activity, Non Value Added Activity, and Necessary Non Value Added Activity, the next step is to make Value Stream Mapping-Current as shown in Figure 7.

From the analysis of Value Stream Analysis Tools in table 3, it can be seen that the highest ranking is Process Activity Mapping. Process Activity Mapping is used to find out all the activities that occur in the food container body production process.

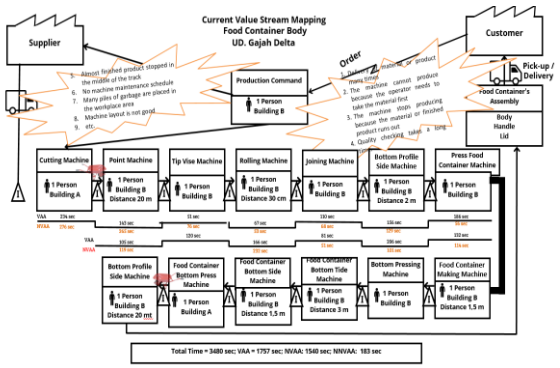


Figure 7. Value Stream Mapping – Current and its problems

By describing Value Stream Mapping, it will be easier to find the problems encountered by considering the biggest wastes that occur, namely transportation, employee behavior, and unnecessary motion. Transportation problems include: delivery of materials or semi-finished products over long distances and requiring multiple pickups, moving finished products to other buildings. Wasteful employee behavior such as, employees often chatting (gossiping) while working, especially when picking up materials in other buildings or during on the way to the place where the materials are picked up, operators insulting other operators, such as when the operator makes a mistake, the machine or the product produced is bad, employee chat (gossip) while working, especially when picking up materials from other building and on trips. Another waste was unnecessary motion such as operators often leave the place to take semi-finished products

that stop in the middle of the track between the machine and the semi-finished product storage tub for the next process, operators move garbage that blocks the operator when carrying materials or semi-finished products, and also often operators take tools that are far away. This can be seen Figure 8.

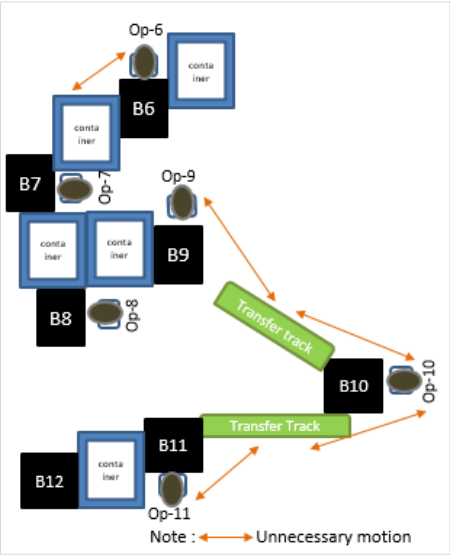


Figure 8. Unnecessary Motion Problem

Those things have an impact on the long production time, resulting in low productivity due to the small amount of output produced. After that, the weighting of the corrective action plan is carried out.

Table 4. Importance, Urgency and Priority Matrix

Improvement Suggestions	Importance	Urgency	Priority	Total IUP	Planning
Employees need to have briefing before and after work	5	5	5	125	1
Competency enhancement through training	5	5	5	125	2
Set a machine maintenance schedule	5	5	5	125	3
Increased operator awareness through briefing	5	4	5	100	4
Delivery work schedule ahead of production	5	4	5	100	5
Create a storage area for waste items	5	5	4	100	6
The transfer track needs to be coated	5	3	5	75	7
Work area cleanliness with 5S	5	5	3	75	8
Machine layout arrangement	5	5	3	75	9
Create bottom shelf for storing raw materials	5	5	3	75	10
Steelmaking to check the quality of roundness	4	3	5	60	11
Installation of stoper on press machine	4	3	4	48	12
Make the shelves for storing semi-finished materials/products	5	3	3	45	13
Make the shelves for storing semi-finished materials/products	5	3	3	45	14
Point creation is done in warehouse A after cutting.	3	3	5	45	15
Changeover of the machine's working process by pressing	3	3	3	27	16
Changeover of 5 machines to 1 double acting machine	5	2	2	20	17

Weighting the corrective action plan by considering the Importance, Urgency and Priority factors as in table 4, the highest total value is obtained, which will be the first corrective activity.

From the proposed improvement recommendations can improve employee performance production time and productivity. Recommendations for improvement of the problems that occur include carrying out briefings and training to improve harmonization of working relationships, increasing cooperation, increasing operator competence, improving employee behavior at work, sharing information to achieve company goals so that good employee behavior is formed. Other improvement suggestions such as, maintenance the schedule, delivery work schedule, create a storage area. Transfer track of semi finish product to be coated, work area cleanliness with 5S, machine relayout, thus transportation and motion processes can be minimized.

Through the improvement steps above, the processing time for making the food container body has improved from 3,480 seconds to 1,868 seconds, this can be seen in Figure 9.

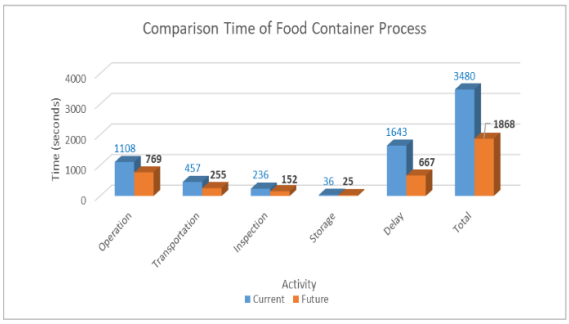


Figure 9. Production Process Time of Food Container Body

The details of the total time calculation include operation time, transportation time, inspection time, storage time, and delay time. A significant decrease in time occurs in the delay time.

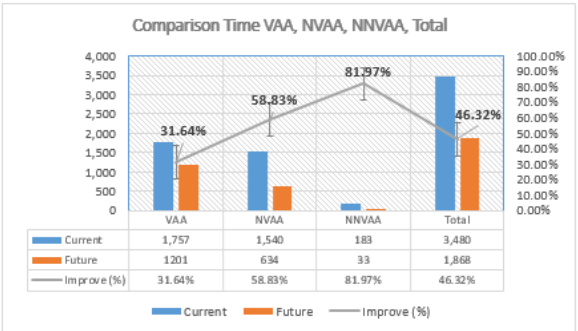


Figure 10. Comparison of Time Before and After Improvement

From Figure 10, it is known that the production process time of the food container body from the above improvements has improved significantly as follows:

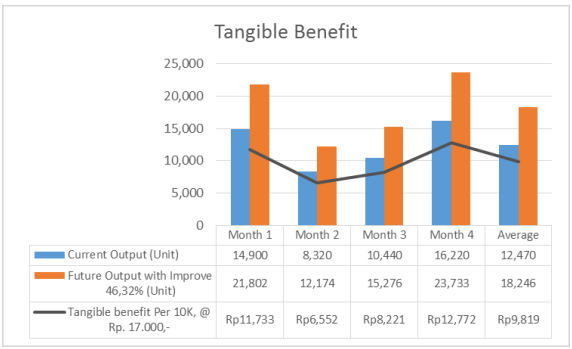
1. The total process time is reduced from 3,480 seconds to 1,868 seconds or gave an improvement of 46.32%.
2. Value Added Activity is reduced from 1,757 seconds to 1,201 seconds or gave an improvement of 31.64%.

3. While Non Value Added Activity time is reduced from 1,540 seconds to 634 seconds or gave an improvement of 58.83%.

From the analysis above, the application of lean manufacturing is able to improve the performance of the process, that is the improvement of total production time from 3,480 seconds to 1,868 seconds, so that there is an increase in average production capacity per month from current data from 12,470 units to 18,246 units. Therefore, there is a potential financial benefit per month of:

Rp. 9.819 x 10.000 = Rp. 98.190.000,-

The calculation of financial profit above is based on figure 11.



	Month 1	Month 2	Month 3	Month 4	Average
Current Output (Unit)	14,900	8,320	10,440	16,220	12,470
Future Output with Improve 46,32% (Unit)	21,802	12,174	15,276	23,733	18,246
Tangible benefit Per 10K, @ Rp. 17.000,-	Rp11,733	Rp6,552	Rp8,221	Rp12,772	Rp9,819

Figure 11. Tangible Benefit from Improvement

In addition to increasing production capacity, it also increases work productivity by eliminating or minimizing non-value-added processes. This productivity increase is from 30.78 to 45.04.
UD Gajah Delta management is expected to continue to make improvements on an ongoing basis so that they have long-term implications for making these MSMEs more independent, producing competitive products and becoming a pillar of technological development, product innovation for kitchen equipment MSMEs in Kebakalan Village, Sidoarjo Regency.

CLOSING

Conclusion

From the data analysis activities and weighting to make improvements, it can be concluded as follows:

1. Implementing lean manufacturing has an impact on the production process time of the rantang body to be faster from 3,480 seconds to 1,868 seconds, or there's an improvement of about 46%.
2. There are improvements in NVAA of 58.83% and VAA of 31.64%.
3. The biggest waste is transportation, employee behavior, and unnecessary motion. Wasteful employee behavior has an influence on the occurrence of other waste.
4. Improvements made are by conducting briefings, training, changing the schedule for delivery of materials or semi-finished products earlier than production, making production bins as well as laying areas, coating production flow paths, cleaning work areas, making work area arrangements.
5. The results of lean manufacturing and IUP Matrix analysis in this MSME can serve as a guideline for other MSMEs, especially those in similar fields to improve their business performance, such as recommendations for conducting briefings before and after work, training, maintenance schedule programs, etc.

Suggestions

To improve the performance of the food container production process time, UD. Gajah Delta needs to do the following:

1. Leaders continue to take corrective actions from the suggestions that have been given, such as changing the way the machine works from rotating to pressing, changing the track between machines from wood to belt conveyor. designing a double-acting machine that can replace 5 existing machines, and optimizing the machine layout.
2. Conduct training for employees on an ongoing basis.
3. Management needs to reward employees who performed well.

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